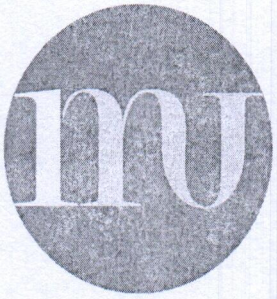
RESEARCH PLAN

ON

DEVELOPMENT OF ONTOLOGICAL FRAMEWORK FOR E-HEALTH SECTOR AND IT'S TESTING THROUGH SPARQL



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Development of Ontological Framework for e-Health Sectorand its Testing through SPARQAL

1. Introduction

E-Governance systems are built for the government to interact with citizens and efficiently provide workflow between the organizations. These systems play major role in efficiently organizing the government knowledge and enabling citizen friendly services. Traditionally E-Governance systems are developed as a requirement basis trend, where the requirement of establishing a service is evaluated and a system for that particular requirement is deployed. There is a need of a framework by which E-Governance system can be deployed in an evolutionary fashion and further services are deployed over the core model. The key element in achieving such evolutionary system is by adding semantics to the knowledge which is represented in the form of Linked Data.In recent times ontologies are considered as a pillar of a growing concept i.e semantic web.

The knowledge expressed in the classical methods cannot be processed by machines. To make machines understand raw data we add semantics using domain ontology. The main aspect of exchanging information among applications, systems, and various services is the development of a consistent and efficient model for representing the domain knowledge. Most widely accepted definitions of ontologies in the field of computer science is that an ontology can be defined as an "explicit and formal specification of a shared conceptualization", Ontologies are capable to provide shared vocabulary, which can be helpful in modeling a domain containing it's concepts, type of objects and their properties along with relationships. Ontology consists of classes (also known as the concepts), axioms, properties (relations) and the instances or it can be represented as a 4-tuple{C, A, P, I} where C is the set of concepts, A is the set of axioms, P is the set of properties and I is the set of instances.

2. Ontology Engineering:

Ontology Engineering is the way to construct the ontologies by using different ontology engineering methodologies which provides the methods for creating the general systems for carrying out the work to be performed Ontology Engineering Methodology primarily focuses on three types of activities which are as follows:

(b) **Development Activities:** It is important to define the procedures for the environment and the feasibility study. After taking the decision of building the ontology the ontology engineer needs the procedures to implement, formalize and specifying the ontology.

(c) **Support Activities:** For the efficient development of the ontology various support activities like: evaluation, merging, integration, knowledge acquisition etc. should be taken care of.

3. Semantic Web

Semantic web is an advanced concept which has generated a revolution in the current web technology of World Wide Web. It is the topmost root in the current web. The concept behind using the semantic web is to provide smart data integration, which creates a form of interoperability between the different agents. In the current web technology, it is not properly handled. A common problem with current web is that the machine is not able to understand what it represents, for this semantic web provides machine understandable meaning and a standard way of achieving data integration in the current web. This is performed by developing a set of vocabulary that has the meaning coded inside its term. In the semantic web a web page will markup the vocabulary with an objective to attain the meaning of the terms used in the vocabulary. This vocabulary is called the ontology in the context of the semantic web, as it is domain specific and it may be of specific area or subject. To avoid or reduce data redundancy semantic heterogeneity is to be maintained, ontology matching plays a crucial role in managing the semantic heterogeneity as it determines the correspondences between concepts of ontologies which are different in nature but semantically equivalent.

4. Role of Ontology in E-Government

Ontology development is becoming very popular in the area of electronic government (E-Government) for last few years as it helps in describing the services provided by the government to the citizens by enabling matching, mapping, and merging of various e-government services, and also it provides semantic integration and interoperability of e-government services. Following are the key reasons for the development of ontologies in E-Government:

(a) Provides a common way of understanding the structures among the peoples.

(b) Gives the facility of extraction of information from different sources and processing of documents.

(c) Gives support to the reuse of existing domain knowledge.

(d) Provides an unambiguous contextual framework which enables the communication between complex and detailed concepts.

(e) Provides a declarative description of the semantic information which is independent of data representation.

(f) Offers the comparison of various objects which are integrated across various heterogeneous repositories.

5. Literature Review

Tanni Mittra, Muhammad Masroor Ali, "Parallelized and Distributed task based ontology matching in clustering environment with semantic verification", CSI Transaction on ICT, Vol.5 September 2017 pp. 265-279.

Recent advancement in ICT make huge amount of heterogeneous information for us. But integration of information semantically and provide machine understandable meaning to information is still a great challenge in current web technology. In overcoming the challenges, ontology matching plays a vital role which is introduced by semantic web technology. Ontology matching is the process of determining correspondences between concepts of different ontologies that are semantically equivalent.

Cui Tao, Dezhao Song, Deepak Sharma, Christopher G. Chute "Semantator: Semantic annotator for converting biomedical text to linked data" *Journal of Bioinformatics (Elsevier)* 46 (2013) 882-893.

Approximately 80% of health care data, as well as the ever growing data online, however, consist of unstructured narratives. Efficiently querying and browsing data embedded in these biomedical documents is an important and challenging task. Traditional search engines such as Google can return users the potential documents of interest based on keywords. Users still have to, however, read through the returned documents until the information of interest is located. In addition, search engines usually return hundreds of thousands of links, many of

which are not relevant to users' search. Domain ontologies can be used in information technology to provide semantic definitions of a particular domain, which enable automated agents to perform queries intelligently and infer new knowledge. Ontology includes a set of classes and their relationships (e.g., class hierarchies and predicates). Semantator provides an environment to link data embedded in text to ontology concepts by using semantic annotation. Information of interest from a document can be annotated as an instance of an ontology class to obtain all the semantic definition of that class.

Ahmed Al-Nazer, Tarek Helmy, Mohammed Al-Mulhem "User's Profile Ontology-Based Semantic Framework for Personalized Food and NutritionRecommendation" ***5th International Conference on Ambient Systems, Networks and Technologies (ANT-2014)*** **Procedia Computer Science 32 (2014) 101 – 108.**

The information on the Web grows exponentially and this makes getting the relevant information more difficult. Many people use the famous search engines, such as Bing, Google and Yahoo, to locate and find information on the Web. The Web search engines, with their limitations, satisfy many people while they many other users are not satisfied because they do not find the search results relevant to their needs. That is obvious when we search for critical information, such as health and nutrition, where we desire more relevant and precise information gathered from trusted sources. Most popular search engines use the keywords to rank the results and they don't consider the trust level of the sources. This is critical in the health and nutrition domain when some foods are restricted to users because of their health conditions. In addition, the search results are not displayed in a structured way which makes it difficult to grasp. Use of semantic processing techniques help in (1) better understanding the users' queries and (2) better structuring the scattered information on the Web. This results in more accurate and relevant search results from specific trusted sources. Semantic ontologies make it easier to integrate with the health and nutrition domain ontologies and helps in reasoning the information using semantic languages such as SPARQL.

Anthoniraj Amalanathan, S. Margret Anouncia, S. Vairamuthu and Magesh Vasudevan "A Framework for E-Governance System using Linked Data and Belief-desire-intention Agent", Indian ***Journal of Science and Technology,*** **Vol 8(15), DOI: 10.17485/ijst/2015/v8i15/54038, July 2015,** ISSN **(Print): 0974-6846 ISSN (Online): 0974-5645.**

The knowledge expressed in the classical methods cannot be processed by machines. To make machines understand raw data we add semantics using domain ontology. Various languages exist to represent Ontology, Web Ontology Language (OWL) is one such language used to

represent linked data in the web; capable of representing the concepts using description logic. The interoperability is the major issue that needs to be addressed in e-governance domain. Interoperability will enhance accessing and coordination among services, transparency, data gathering and parsing techniques for decision making.

Vallet D., Fernández M., Castells P. (2005) An Ontology-Based Information Retrieval Model. In: Gómez-Pérez A., Euzenat J. (eds) The Semantic Web: Research and Applications. ESWC 2005. Lecture Notes in Computer Science, vol 3532. Springer, Berlin, Heidelberg.

Rather than an instrument for building knowledge bases, these light-weight ontologies provide controlled vocabularies for the classification of content, and rarely surpass several KBs in size. This approach has brought improvements over classic keyword-based search through e.g. query expansion based on class hierarchies and rules on relationships, or multifaceted searching and browsing.

Song YT., Torkian N., Al-Dossary F. (2015) Ontological Personal Healthcare Using Medical Standards. In: Ortuño F., Rojas I. (eds) Bioinformatics and Biomedical Engineering. IWBBIO 2015. Lecture Notes in Computer Science, vol 9044. Springer, Cham.

According to The Center for Managing Chronic Diseases 7 out of 10 deaths among Americans each year are from chronic diseases. Chronic diseases generally do not come with a cure, which require long-term supervision, monitoring, and various treatments that necessitate coordination among medical professionals. Information and Communication Technology (ICT) may help improve such process and be able to facilitate diverse clinical decision making processes. The ontology focuses on organizing measurement results semantically. For semantic verification of the collected medical records, Protégé-OWL can be used for building ontology and SPARQL query to retrieve meaningful information from the patient-provided medical data.

M. Rani, R. Nayak, and O. P. Vyas. "An ontology-based adaptive personalized e-learning system, assisted by software agents on cloud storage." Knowledge-Based Systems 90 (2015): 33-48.

E-Learning and online education has made great strides in the recent past. It has moved from a knowledge transfer model to a highly intellect, swift and interactive proposition capable of advanced decision-making abilities. The emerging semantic web needs to develop an e-learning system which focuses on personalized and adaptive learning style of learners rather

than just content delivery. Some issues of current e-learning system are to manage huge continuous growing e-learning content on the internet, searching an appropriate e-learning content as per the learner's requirement, represent knowledge in machine readable format with reasoning capability and also to allow reuse of e-learning material. All these issues are addressed by using ontologies for storing e-learning content and building an e-learning application for the semantic web. The ontology presents the course taxonomies in an unambiguous format which is its main resolution.

Mahdi Ben Alaya, Samir Medjiah, Thierry Monteil, and Khalil Drira "Toward Semantic Interoperability in one M2M Architecture" IEEE Communications Magazine — Communications Standards Supplement • December 2015.

The oneM2M standard is a global initiative led jointly by major standards organizations around the world in order to develop a unique architecture for M2M communications. Prior standards, and also oneM2M, while focusing on achieving interoperability at the communication level, do not achieve interoperability at the semantic level. Semantic data is brought through the definition of a common set of ontologies that describe all system entities but also the data items produced, exchanged, and consumed by these entities.

A. Gyrard, M. Serrano and G. A. Atemezing, "Semantic web methodologies, best practices and ontology engineering applied to Internet of Things," *2015 IEEE 2nd World Forum on Internet of Things (WF-IoT)*, Milan, 2015, pp. 412-417. doi: 10.1109/WF-IoT.2015.7389090

Semantic web technologies are getting more used to enhance semantic interoperability within project. Recently, semantic web technologies are integrating to Internet of Things Designing ontology is getting more and more popular to ease the interoperability among applications, services, software's and platforms and for describing the domain knowledge. The main benefits of using ontologies are: (1) exchanging data among systems, (2) providing interoperability among systems, (3) designing knowledge, (4) sharing knowledge, and (5) simplifying operations.

José Marcelo Cestari, Mario Lezoche, Eduardo Rocha Loures, Hervé Panetto, Eduardo Portela Santos. "A method for e-government concepts interoperability assessment. Society for Information Systems and Computer Networks". 4th *International Conference on Information Society and Technology, ICIST 2014,* Mar 2014, Kopaonik, Serbia. pp.79-85, 2014.

With the raising of eGovernment concepts and the increase use of ICT by public administration entities, the need for collaboration among these organizations is a reality with which systems, managers and other stakeholders must deal. In order to increase performance, to supply the online services, and the search for cost reductions the governments paradigms focus, now more than ever, on how to better manage information. Interoperability is a key factor for organizations facing with collaborative-cooperative environments. Considering the concepts in an integrated way, the eGovernment interoperability domain arises as the ability of constituencies or public agencies to work together attempting to meet interoperability requirements.

Wajahat Ali Khan · Asad Masood Khattak ·Maqbool Hussain ·Muhammad Bilal Amin ·Muhammad Afzal · Christopher Nugent · Sungyoung Lee, "An Adaptive Semantic based Mediation System for Data Interoperability among Health Information Systems" ***Journal of Medical Systems*****, 2014 Volume 38, No. 8 https://doi.org/10.1007/s10916-014-0028-y.**

Heterogeneity in the management of the complex medical data, obstructs the attainment of data level interoperability among Health Information Systems (HIS). This diversity is dependent on the compliance of HISs with different healthcare standards. Its solution demands a mediation system for the accurate interpretation of data indifferent heterogeneous formats for achieving data interoperability. The solution to handle complex medical data exchange is achieving interoperability. Technical and semantic interoperability can only be achieved when existing standards are harmonized and Bridged.

Remi S , Varghese S C "Domain Ontology Driven Fuzzy Semantic Information Retrieval" Proceedings of the ***International Conference on Information and Communication Technologies*****, ICICT 2014, 3-5 December 2014, Procedia Computer Science 46 (2015) 676 – 681.**

With the exponential growth in web content, the answers provided by traditional search engines by query specific keywords to content has resulted in markedly high recall and low precision. Semantic information retrieval can enhance the relevancy of search results by understanding search intention and the contextual meaning of terms as they are entered by the user. To find relevant information related to a particular subject from the huge data present on internet, an efficient search technique is necessary. Semantic search means searching the web on the basis of meaning of user query. For supporting effective keyword search by producing more relevant search results, it is necessary to understand and interpret the query in the way user wants. Ontology is a semantic web tool that is being increasingly used for

building the applications for the specific domain. Ontology enables users to capture the semantic of the documents.

B. Di Martino, G. Cretella, A. Esposito, A. Willner, A. Alloush , D. Bernstein "Towards an Ontology-based Intercloud Resource Catalogue" ***IEEE International Conference on Cloud Engineering (IC2E),*** **9-13 March 2015** DOI: **10.1109/IC2E.2015.76** , ISBN: **978-1-4799-8218-9.**

Cloud Computing has been attracting the interest of the Information Technology industry since at least 2007. It has been seen as the next logical step after Grid computing on the way to utility computing, where computing resources are available according to a subscription utility service model, just like the electricity system, the telephone system, or more recently the Internet. However, unlike the electricity system, the telephone system, or the Internet, Compute Clouds cannot yet federate and interoperate. Whenever a single vendor-locked Compute Cloud service is used, its unavailability can leave thousands of customers, relying solely on it, without access to essential and paid for resources. Also relying on a single Compute Cloud service makes it hard to implement adequate responsiveness and usability to clients distributed worldwide.

Nelia Lasierra, Alvaro Alesanco, and Jose Garcia, "Designing an architecture for monitoring patients at home: Ontologies and Web Services for Clinical and Technical Management Integration" in ***IEEE Journal of Biomedical and Health Informatics*****, Vol.18 No.3, May2014 pp.896-906.**

Telemonitoring systems face the problem of delivering medicine to the current growing population with chronic condition s while at the same time covering the dimensions of quality of care and new paradigms such as empowerment can be supported. Interoperability and integration are the critical challenges that also need to be addressed when developing monitoring systems in order to provide effective health care and to make possible seamless communication among the different heterogeneous health entities.

6. Research Gaps

On the basis of the literature survey following research gaps have been observed:

a. Interoperability issues are still a challenging task
b. Data management issues associated with the heterogeneous data
c. Lack of e-health services especially in India

b. Data management issues associated with the heterogeneous data

c. Lack of e-health services especially in India

d. Lack of effectiveness of existing e-health services in terms of cost, availability and monitoring

e. Lack of Semantic search based conceptual searching to search a specific content without ambiguity

f. Reusability issue with the existing ontologies

g. Lack of personalized recommendation systems

7. Objectives

In consideration with the abovementioned research gap, the following objectives have been considered for the proposed research plan:

a. To develop efficient and plausible ontologies for conceptualization of framework for e-health sector in India.

b. To develop a predictive framework based upon the symptoms of several chronic diseases.

c. To use efficient clustering algorithm(s) (e.g. k-means,Naive Bayes Algorithm, etc.) for development of recommendation system.

8. Methodology

a) Collection of primary data through personal interaction or through interview schedule from both the stakeholders *viz*doctors and citizen. The current literature is revealing that; the Indian society is suffering from obliviousness attitude of the Government in the domain of health monitoring, but, in order to get the grass root realities, the survey among various stakeholders is necessary. So, that the implications can also be taken care of while development of the framework.

b) Development of ontologies for the said problem by using Protégé 5.0.

c) Enforcement of the resoners like Hermit, Pellet, Fact++ etc. to check the consistency of developed ontology

d) Testing of the framework through SPARQL for analyzing the expected outcomes of the proposed framework.

9. Limitation

a. The proposed framework will be based upon the outcomes of the secondary data and responses accumulated through primary sources.

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